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OF THE

Society for the Promotion of Engineering Education

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EDITORIALS.

Common Sense in Engineering Graduates.—In this issue of the BULLETIN are printed two communications from engineers practicing in different but related branches of civil engineering. Mr. Tyrrell gives an incident which has recently come within the range of his personal experience and which seems to indicate faulty technical instruction. In his article

on highway engineering education Major Crosby deplores the lack of certain qualities in technical graduates. He believes that these could be eliminated by certain changes in the curriculum. His criticisms and suggestions should be carefully considered by the technical educator. While probably few will agree with Major Crosby as to the remedy, all will grant that there is much force in his analysis of the conditions. Courses of study are merely the mechanism of the educational process. The education itself is largely a matter of "atmosphere." If the teachers are the kind of men the students ought to be and if the everyday life of the school reflects, in some measure, the difficulties and the triumphs of the business world, then the students will be prepared for the activities of life. Too much, however, must not be expected from a four-year technical course. All that it can do is to furnish a directive influence during the period when a boy is becoming a man. It cannot "make a man" of him—he does that for himself.

A recent speaker in a college lecture defined the aim of education as "independent activity." This, after all, is the test and it is the lack of independent and well-directed activity that Major Crosby deplores.

Honors for Foreign Students.—The newspapers have made much of the fact that out of nine men elected to Phi Beta Kappa at Cornell this year three are Chinese. The conclusion is drawn that American students are lacking in appreciation of their educational opportunities and that, to quote the Columbus Dispatch, "American boys are losing the sense of scholarship. . . . There seems to be an educational swim, and there are thousands in it floating down to the gulf of the commonplace." From the educator's standpoint this is "drawing it pretty strong" but the circumstance warrants attention, assuming that the persons responsible for the above election studied carefully the records upon which the election was based. The ratio of Chinese to American students at Cornell is roughly one per cent. Obviously then the proportion elected to Phi Beta Kappa was remarkable. It indicates

that, even when handicapped by language, customs and in some cases inadequate preparation, the Chinese student is "making good." The Chinese students are picked men from a country of scholars and of shrewd business men. Their native thrift combined with good mentality inclines them to make the most of their opportunities. The very obstacles placed in their way are incentives to their best effort. They know, furthermore, that they must be able to do things when they return home. As one of the writer's Chinese students said recently, "When I get back home they will expect me to know things. I must learn them in this country, not only theoretically but practically."

But what about the poor American student "floating down the gulf of the commonplace"; where does he come in? Well, he's making good too. Possibly his college grades are not as high as they might be, but on the whole they are satisfactory. He is being educated, however, in a broad way in spite of the fact that he does not appreciate his opportunities as he should. Nevertheless he ought to thank the foreigners for the stimulus that they furnish by carrying off honors that he could earn if he set his mind to the task.

Utilizing the Summer Vacations.—Many students realize the importance of proper use of the summer vacations but do not know how to get suitable work. The statistics furnished in Professor McKibben's Minneapolis paper show that a very fair proportion of undergraduates do find temporary occupation in engineering lines. It is possible that civil engineering affords better opportunity for this than manufacturing or public service as students are not immediately useful in the latter. In fact summer students are more trouble than they are worth in many cases. At the same time summer employment is good for the students and therefore for the industries. The young men are being educated for engineering work and it is a duty of future employers to give them such opportunity as is possible without deranging the regular forces. If the Minneapolis meeting can give encouragement to the movement for better use of the summer vacation it may be possible to lend it the weight of the Society's influence.

How Long Shall the Engineering Course Be?—At the Minneapolis meeting this much-discussed question will come up again for review. It should be brought up again for it is a momentous question. President Humphreys and Professor Swain will champion the four-year course and they present sound arguments in the papers printed elsewhere in this issue. Before the course is lengthened generally, firm conviction must result from a careful study of all phases of the subject. It is a large economic cost to keep all boys or men in school a year longer than at present. Is the gain worth this cost? These writers say "no." They are both practicing engineers as well as educators. They have studied the matter from both standpoints. President Humphreys asks numerous questions and gives his own answers. A good mental exercise for all of us will be to ask ourselves these questions and answer them in the light of our own experience. A comparison with the views of these eminent educators will furnish interesting discussion for the meeting.

Next Year's Bulletin.—Three volumes of the BULLETIN are practically complete. These contain many interesting and helpful contributions from the members of the Society and others. The pages of the fourth volume are open for the discussion of live topics. The members must fill them. While the editor would not urge any one to write simply to fill space he knows that much thought and experimentation are being devoted to improvements in instruction. Then there is the whole field of the science of education to which little attention has been given by the Society. This work should be recorded in the BULLETIN. Technical education is far from perfect according to the criticisms directed at the schools. What are you doing to improve it? Tell the membership through the BULLETIN.

APPLICANTS FOR ADMISSION.

DIBERT, H. M., Civil Engineer with W. & L. E. Gurley, Troy, N. Y. 1913
DREYER, C. F., Head of the Department of Mechanical Engineering, Escola de Engenharia, Porto Alegre, Brazil 1913

EMERSON, HARRINGTON, President, The Emerson Company, 30 Church St., New York, N. Y. 1913
HITCHCOCK, F. A., Instructor in Civil Engineering, Cornell University, Ithaca, N. Y. 1913
NASH, C. A., Instructor in Electrical Engineering, University of Maine, Orono, Me. 1913
SIMMERING, S. L., Graduate Fellow in Mechanical Engineering, University of Illinois, Urbana, Ill. 1913
SMOLEY, C. K., Principal, International Correspondence Schools, Scranton, Pa. 1913
STREETER, R. L., Assistant Professor of Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1913
WHITE, E. C., Instructor in Railroad Engineering, Cornell University, Ithaca, N. Y. 1913

SOCIETY BUSINESS.

THE MINNEAPOLIS MEETING.

June 24 to 26, 1913.

The Program Committee is having excellent success in carrying out its plan for the meeting. There will be a comparatively small number of papers, but these will treat of live topics. While the complete list of papers cannot be announced yet a number are mentioned below. Abstracts or full texts of most of the papers will appear in the BULLETIN next month. Three are printed in this issue.

In addition to the above and other papers bearing on the same general topics there will be reports from the regular committees and from the five special committees appointed last year. The latter deal with College Administration and Improvement in Mechanical, Civil, Mining and Electrical Engineering Laboratory Instruction. Special sessions to be presided over by Prof. A. H. Blanchard and Dean Anson Marston respectively will consider the problems of highway engineering instruction and the problems pertaining to the engineering colleges and departments of the land grant colleges. The president's address will be the central feature of one session.

CONVENTION PAPERS (PARTIAL LIST).

Authors.	Title.	Topic.
Chas. F. Cahill	Of the United Shoe Machinery Co.	Application of the Principles of Scientific Management to Education.
Philander P. Claxton	United States Commissioner of Education	The Science of Engineering Education.
H. Wade Hibbard .	Professor of Mechanical Engineering, University of Missouri.	The Thesis. Shall We Abolish it or Not?
Alex. C. Humphreys	President of the Stevens Institute of Technology.	Four vs. Five or More Years of Collegiate Education.
E. D. Jabine	First Assistant Engineer, N. Y. C. & H. R. R. R. Co.	How Can the Colleges and the Industries Cooperate?
Ivy L. Lee	Executive Assistant, The Pennsylvania R. R. Co.	How Can the Colleges and the Industries Cooperate?
A. B. McDaniel ...	Assistant Professor of Civil Engineering, University of Illinois.	Coordination in Engineering Instruction.
H. S. Person	Director of Tuck School, Dartmouth College.	Application of the Principles of Efficiency to Education.
C. Russ Richards ..	Professor of Mechanical Engineering, University of Illinois.	Ideals of College Laboratory Construction.
E. C. Schmidt	Professor of Railway Engineering, University of Illinois.	The University of Illinois Transportation Building.
C. E. Sherman	Professor of Civil Engineering, The Ohio State University.	Summer Camps for Engineering Students.
Geo. F. Swain	Professor of Civil Engineering, Harvard University.	Four vs. Five or More Years of Collegiate Instruction.
D. M. Wright	Secretary and Treasurer, The Henry & Wright Mfg. Co.	The Revision and Standardization of English Technical Terms.

LETTER TO THE EDITOR.

SECRETARY S. P. E. E.,

Dear Sir: Last fall I supplied instructors in my department with what, for lack of a better name, I called "Rules for Conducting Classes." It has been suggested that I send you a copy to publish in the S. P. E. E. BULLETIN, so as to give members an opportunity to comment upon the matter.

Of course, it is realized that the manner of conducting a class must, to a large extent, be governed by the subject of the course, the time available, the number and preparation of those taking the course, etc. However, in starting new instructors in our work, even when they have had a little teaching experience, we have found that suggestions, such as these, have often been very helpful.

It will be of interest to know to what extent other colleges have attempted to assist, by suggestions or otherwise, the younger members of the instructing staff in the proper conduct of their classes.

Yours truly,
ARTHUR C. JEWETT.

UNIVERSITY OF MAINE,
March 22, 1913.

RULES FOR CONDUCTING CLASSES.

An advance assignment of lesson for preparation is always to be made, and its length to be carefully determined so as to occupy the average student about one hour and a half.

Whenever possible the preparation of a lesson shall involve some other work than reading; *i. e.*, shall involve putting down upon paper for the instructor's inspection either problems, or written description such as will involve actual knowledge of the lesson.

An attempt shall be made to obtain a recitation from each student at each exercise. For every recitation a grade shall be given, and, when feasible, the student shall know approximately the grade given.

"Prelims" shall be held frequently, say one to every five or six lessons. The student's average grade in course to date shall be given him, approximately, whenever he asks for it.

Lecturing is to be avoided. The only use of lecturing shall be to give the student that which he cannot readily obtain for himself from the chosen text or from assigned references. Difficulties likely to arise from the text in connection with an assigned lesson shall be anticipated wherever possible and explained when making the advance assignment, in such a way that the student shall note the point.

There will occasionally arise unforeseen difficulties which the student shall be encouraged to bring up in class for illumination, either by other members of the class, or, if that is not possible, by the instructor. The instructor will endeavor to illustrate the matter in hand, as to application, etc., in as interesting a way as possible. Descriptions, pictures by

lantern, and when possible, visits of inspection are all to be requisitioned in this connection. This paragraph indicates the extent and nature of the usual talk from an instructor to his class. A *little* time must be devoted to this at each exercise. The longer talks and illustrative matter shall, so far as possible, be introduced at times when, for apparent reasons, the entire class is likely to have made little preparation, such as after a night devoted to a general college celebration, or during the first exercise in a subject.

In all recitation work, either at black-board or written at seats, neatness and accuracy is to be strongly encouraged. This should be particularly emphasized in sketches and mathematical work.

As far as possible the entire course shall be outlined in advance and the student allowed to know what he is to accomplish in it.

Rules made for the benefit of the class should be written down, and then not deviated from except that the whole rule be revised for the benefit of the whole class.

It should not be necessary to say that the instructor must be most thoroughly acquainted with both the advance assignment and the day's lesson, and should prepare himself on the lesson for each class in a broader way than is expected of the student.

PERSONAL NOTES.

Mr. Clifford B. Richardson announces the removal of his office from 30 Church St., to Room 1615, Woolworth Building, 233 Broadway, New York, N. Y.

Professor Arthur H. Blanchard, of the highway engineering department of Columbia University, delivered an illustrated lecture on Highway Engineering in Europe and America before the Brooklyn Institute of Arts and Sciences on March 31; also a lecture entitled "Modern Bituminous Pavements for Municipalities," before the Board of Trade of Elizabeth, N. J., on April 10.

Professor H. H. Higbie, of Wentworth Institute, has been appointed Professor of Electrical Engineering at the University of Michigan and will take up his residence at Ann Arbor sometime during August.

Dr. Wm. Paul Gerhard, Consulting Engineer, has removed his office from Brooklyn to the Forty-second Street Building, corner Madison Ave. and 42d St., New York, N. Y.

Dr. Louis Duncan has removed his offices from 55 Liberty Street to 50 Church Street, New York, N. Y., and is now associated with the firm of Duncan, Young & Pressey, Inc.

John Wiley & Sons., Inc., of which Mr. W. O. Wiley, treasurer of this Society, is secretary, announce their removal from 43 and 45 East 19th St. to 432 Fourth Ave., New York, N. Y.

Mr. J. C. Wait announces the removal of his offices from 38 Park Row to the Woolworth Building, 233 Broadway, New York, N. Y.

PUBLICATIONS RECEIVED.

Better Roads, Vol. III, No. 3.—A monthly magazine devoted to highway engineering and the improvement of roads throughout the country.

State of Ohio Highway Department. Bulletins Nos. 12, 13, 15, 16, 18. —Addresses and reports by state highway commissioners.

The Minnesota Engineer, Vol. 21, No. 2, containing among other articles An Appreciation of Arthur Edwin Haynes, professor emeritus of engineering mathematics, University of Minnesota, by Dean F. C. Shenehon; The Mississippi River High Dam Project, by Prof. J. J. Flather; Campus Grading on the Engineering and Medical Groups, by Prof. O. S. Zelner.

Bulletin, No. 61, of the University of Illinois Engineering Experiment Station.—Characteristics and Limitations of the Series Transformer, by A. R. Anderson and H. R. Woodrow.

The Iowa Engineer, Vol. 13, No. 6.—Containing an article by Prof. F. A. Fish on The Accuracy of Engineering Computations.

Sanitary Engineering at Harvard University.—This pamphlet describes briefly the opportunities at Harvard for the study of Sanitary Engineering and the various sciences that bear upon the general subject of public health.

The New Locomotive Laboratory at the University of Illinois, by Prof. Edward C. Schmidt. A profusely illustrated copy of a paper presented before the March meeting of the Western Railway Club.

The Technograph, Vol. XXVII, No. 3.—Containing among others an article by Mr. F. C. Loring entitled A High Voltage Testing Equipment. Mr. Loring describes the new high-voltage equipment at the University of Illinois, giving construction of the transformer, method of operating, and also A Bibliography of High Voltage Transmission and Testing.

HIGHWAY ENGINEERING EDUCATION.

BY W. W. CROSBY,

Consulting Engineer, Baltimore, Md.

After associating with engineering employees of all kinds for more than twenty-five years and employing such for half that time, the writer has become awake to the apparent deficiencies in the education of such men, as well as of his own, and deeply interested in the problem of how, in the future, to prevent such defects.

Perhaps it would be wise, before going further, to specify the defects the writer has noticed. They are: (*a*) Lack of knowledge of English; (*b*) lack of knowledge of accounting, book-keeping and finance; (*c*) lack of application and persistence; (*d*) lack of knowledge of cultural subjects; (*e*) lack of breadth of view.

Now, (*a*) a lack of knowledge of English, both oral and written, is serious and deplorable. It interferes with the progress of the individual, makes him less valuable to his employers and may even prevent his retaining his position if there comes a demand on him for concise intelligible reports of fact, let alone any demands for opinions or deductions from facts.

An idea cannot be clearly expressed unless it is clearly thought. Conversely, clear thoughts generally mean clear expression though not always so. But there should be no exceptions. Many engineers have clear conceptions that they seem unable to express clearly in words. How often it occurs that an engineer relies on his pencil and a piece of paper, or on a blackboard and chalk, to illustrate an idea, when a lawyer, for instance, would equally well convey the thought—perhaps even more clearly to many—in language. This state of affairs

surely does not conduce to greater appreciation of the engineer by the public. The writer has often called for written reports from subordinates concerning pieces of work and has only too often been obliged to return such for explanation as to their meaning—naturally not a gratifying procedure to either party, to say nothing of the time and money lost purely from lack of ability in English expression.

(*b*) Nowadays, the efficiency side of engineering is demanding more attention than perhaps has been the case in the earlier days. Many young engineers are employed in ascertaining the costs of work done, many older ones have to keep track of these costs in order to properly manage their work. Others are engaged in comparing costs, in planning for their reduction or in predicating the costs of work to be done. Few of the younger engineers seem to know anything at all of the principles of cost keeping, accounting or of financial matters generally. Many know so little that they are unable to properly record the daily expenditures of labor, material, etc., in such a way that the elementary costs of the items completed can be arrived at even approximately. And the writer has been unable to get hold of a sufficient number of engineers who seemed to understand the first principles of arriving at overhead charges, depreciation, sinking fund and interest charges, etc. Yet these insufficient men have been placed in responsible positions, such as that of county engineer, where not only were hundreds of thousands of dollars of expenditures to be accounted for annually by them, but also in many cases they were to be the guiding spirits in framing laws for the borrowing and expenditure of many more such sums.

(*c*) Too many graduates fresh from college seem to have difficulty in settling down to work with a determination to advance in their chosen profession of engineering. For the first few days perhaps the novelty inspires them to industry and the acquisition of knowledge concerning their work. Then a base-ball game or some other afternoon function of sporting or social interest happens contemporaneously with the demand for some slope stakes to be set for the contractor or for a

monthly estimate to be made out, checked and issued between Friday night and Monday morning and the new man either fails to understand why he cannot be allowed to attend the ball game or he performs his duties so poorly as to make his superior question the wisdom of continuing him longer in the corps.

After two or three months' work in the summer, perhaps the shooting season comes on and he wants a vacation of a few days to enjoy it. Then at Christmas he probably desires to spend the holidays at home. In the spring, all sorts of desires come to young men. Let us assume he craves "to go a-fishing." And then when summer comes again he wants a vacation after a year's hard work in order to rest and recuperate and because it is vacation season. If he has not had all the vacations he has desired, he has really suffered in a way from the deprivation and his work has suffered accordingly. The fault is not really his; he has been injudiciously reared and allowed to accustom himself to vacations till too late a period in his life.

The writer believes that during the two latter years of the ordinary college course too much vacation is accorded engineering students and that some of the deficiencies of college graduates would be removed by utilizing with work some of the vacation periods of those years. Thereby also, he believes that application and persistence would be developed and enhanced.* As it is now, the employer has to use a year or more with many graduates fresh from college in developing both traits.

(*d*) The engineer looks to capital for employment, and capital is either in the hands of cultured persons or of persons who at heart have the deepest admiration for culture. By culture is meant not that superficial knowledge of many common and uncommon things but, as defined elsewhere, that education which enables its possessor to better sympathize with the good ideals of others and to most fully appreciate and enjoy all the good things of this world—or, in other words, to

* See PROC. S. P. E. E., Vol. XIX (1912), p. 151.

get out of the swine class, and to learn to appreciate, if not to distribute, pearls.

Aside from the intrinsic value of culture to the individual, it is a fact that its possession will enable the engineer enjoying it to make a better appearance before capital and to attract capital to his personal benefit. Too many engineers content themselves with polishing their technical knowledge to a fine degree, and then complain because of lack of opportunity given them to use such knowledge or because in their opinion they are insufficiently remunerated for its use. The trouble rests with themselves. Capital is not attracted by such men and only most rarely is in a position where it needs to go directly to them for their services. Even when it does require their services, it fails to appreciate any difference in ability and, because of the competition, generally secures the services temporarily desired at a low figure. Moreover, most capitalists take time from their financial affairs for extraneous matters; generally seeking cultural subjects, if not for diversion, because of their admiration for such. The engineer who seeks the alliance of capital must be prepared to entertain it during these excursions and contemporaneously to make a favorable impression, or he must await those far rarer opportunities when capital and science meet. Discussions of the graphical analysis of stress in framed structures are, if at all, of only passing interest to most capitalists and it will be difficult for the most expert therein to favorably impress the financial powers if he rely solely on his expertness along this line for such impression. An engineer sufficiently qualified for his technical work however, if he be able to interest laymen on lay subjects, will have far less difficulty in securing opportunities to use his professional knowledge.

The tendency of the earnest, conscientious, scientific man is to become a "bore" and there is great need of education to offset this tendency.

In regard to culture, we cannot do better than quote the words of Rev. James Gow:

"Of late years the general educated public has become much more numerous and more highly educated, and I suspect that a time is at hand when it will be advantageous to the engineer to mingle the '*utile*' with the '*dulce*'; to discern not only what is mathematically possible, but also what is artistically impossible; not only what is cheap, but also what is nasty. For this purpose some general culture is necessary, some critical faculty, some pleasure in beauty, some habit of reading and delight in reading such as makes a man liberal in mind and sympathetic to the common run of his fellows."

(*e*) Allied to the immediately foregoing and perhaps difficult of separation from it is the subject of breadth of view.

Few professional men need broader foundations in education upon which to stand and build than engineers, called upon as they are (and increasingly so) to direct works of the largest magnitude, for the proper and successful execution of which is demanded the farthest and most comprehensive observation.

Take, for instance, the work of a city engineer—one of the higher positions to which a highway engineer may legitimately aspire. In the details of his work he should be able to sympathize with builders who are frequently forced to occupy for a considerable period a generous portion of the street width; with telephone and telegraph companies who have to make excavations through his pavements; with street railway officials striving to comply at the same time with the demands of their financial backers and those of the public; with the small property owner or taxpayer who perhaps pays more in proportion into the public funds; with the large taxpayer who considers himself important largely because of the size of his contribution; with the critic and the reformer who can tell him how things ought not to be or ought to be done; with the politician whose ideal is an organization of affairs that will perpetuate himself in power; and in short, with the thousand and one various interests and view points inevitable in our system of government and under our national or local conditions. And with this ability to sympathize with these various interests, to recognize and to know them, he must have the ability to lay the

proper course and then to keep to it in spite of storms or other efforts at diversion.

The same is true in the case of a state-highway engineer or the chief engineer to a state-highway commission; and it must be remembered further, that, while many times much can be accomplished in a short period of office-holding, a longer period offers more opportunity and generally produces more results. Hence the efficient official who, by being broadmindedly and farsightedly diplomatic, does good work for a longer period, is more successful than he who does it for a shorter one. Official persistence to the establishment of a good policy is often worth much to the employing public or stockholders, but where bold or big things are being done, tact and diplomacy are generally necessary if the official is to retain his opportunities to do.

Further, tact and diplomacy, if not proceeding from breadth simply degenerate into weakness and "trimming." Sympathy underlies tact. Sympathy proceeds from understanding and understanding can only come from comprehensive observation. An overlooking viewpoint nowadays can only be reared from a broad and stable foundation.

Conditions for doing constructive work are rarely if ever ideal. How many engineers have ascribed their failures to secure the results desired to the opposition of some individual or group of interests. They knew they were right in theory but opposing conditions apparently prevented success. And yet other engineers have succeeded in spite of opposition even stronger. May it not frequently be the case that the success followed the broader man. To the one probably it seemed that "the times were out of joint," the opposing conditions were not of an engineering character and consequently not for the engineer to handle, and the responsibility for failure not his. "Had conditions, other than the technical ones, been right," he would "have produced good results."

To the other engineer who did succeed, probably the only thought was: "Here's another obstacle. But it might be

worse. Now for getting around or by that." And he sized up the obstacles and went past all such to success.

Enough has perhaps been said on this line to indicate why some narrow though skillful technicians fail when placed in charge of big works and why broader, if perhaps less skillful, men succeed. The success certainly could have been greater had breadth and skill or technical knowledge been combined.

It seems to the writer that it is this personified combination that the public and capital are persistently looking for among engineers. They have frequently succeeded in finding it but not as often as desired and frequently they have been disappointed in their apparent discoveries, more generally in the quality of breadth than in that of skill. But they persist naturally in trying to find the desired article in the engineering profession and, with the march of events, the educators of engineers should recognize the situation, the increase to come in the rigor of the search and the increasing value of the prize sought, and prepare to supply more nearly the article wanted.

Earlier arrival at the desired ends should of course be expected if the start be made sooner. Many engineers arrive too late through not starting many of the lines of study until after their graduation. But it seems to the writer that in most cases an earlier start might have been made by beginning at least many of these studies in the college. There are perhaps some that could best be taught in a postgraduate course and therefore should be covered there. As the writer remembers his college days, they were full of pleasure and generously divided between play and work. He now feels that considerable of the period was wasted, through no fault of his own and in spite of the fact that he did considerable engineering work during his vacations. He now regrets the length of the latter.

The cry comes that the engineering courses are already crowded with the "necessaries" and that it is difficult, if not impracticable, to introduce "cultural studies." The complaint is also heard that the engineering profession is overcrowded and underpaid, and that a lot of men are posing as "C.E.'s," who are not entitled to do so and who are contributing by their

so doing to the depreciation of the value of real engineering services.

It seems to the writer that conditions would be improved by proceeding along the following lines:

1. Broaden the education of the engineer to practically the limits of the academic courses during the first two years at college.

2. Begin to add engineering studies in the junior year mainly by cutting the usual vacations during that year in half and using the additional time for the purpose.

3. Complete the teaching of the general engineering subjects in the senior year by substituting for some of the academic studies the necessary technical ones and by utilizing the additional time secured by again cutting in half the reduced vacations of the junior year.

4. Omit entirely from the college course of four years any specialization in branches of civil engineering.

5. Graduate only those who survive the above properly with a degree such as B.S. in C.E.

6. Provide postgraduate courses—similar to the one at Columbia in highway engineering—where specialties can be taken and where a degree of M.S. will be given after proper preparation of not less than one year.

The writer would drop "C.E." from the list of degrees given because of the improper use of it that has grown up and because it so readily lends itself to such use.

It may be said that the writer's proposition above outlined makes it hard for the poor but deserving youth who might otherwise turn out to be a great engineer, and it is possible that some such instances would occur under it. But is it by all means certain that the doctrine of the survival of the fittest is entirely wrong?

Harrington Emerson says: "The average wisdom of government is the mean between the fool and the wise man. The way to better man in the aggregate is not to lessen the responsibility of each unit, but to increase it, to bring from within the poorest units up to the level of the present best and to have

the present best establish a higher standard," or, in other words, if we wipe out the fool engineer or prevent his establishment, even if we do not improve "the present best," we raise the level of the average.

But the writer believes, even with the restricted opportunities allowed by his scheme, the "present best" would "establish higher standards"; the worthy potential Stevensons, Macadams and Nobles would still develop, possibly even further, and that immense good would be done the profession as a whole.

EDUCATIONAL ESSENTIALS FOR BRIDGE ENGINEERS.

BY HENRY GRATTAN TYRRELL,

Consulting Engineer, Evanston, Ill.

My attention has lately been called to a serious lack in engineering education, a description of which will be especially interesting to bridge engineers. In order to explain the matter I will relate the incidents without giving names.

I was recently employed by one of the large railroad systems to make special investigations and reports on bridges scattered over 700 to 800 miles of railway. The company was equipped with a full engineering corps including separate departments for bridges and buildings with a drafting force of twenty to thirty men under the direction of two men with titles of engineer of bridges and engineer of buildings, respectively.

Double tracking and bridge renewals were being considered, and the railroad company was in doubt as to the proper type and length of bridges to specify. Guesses had been made by the man who was then chief engineer of the road, as well as by his predecessor, and division engineers had also given their views as to the need of bridges in certain places and their required length. As the various reports and opinions of the two chief engineers with the bridge engineers and their associates differed by 400 to 500 per cent., it was decided to secure a report from a specialist. In one case where the road crossed the same stream three times under similar conditions, the longest bridge was three times longer than the shortest one and for no other reason than difference of opinion, as the shorter structure served every useful purpose quite as well as the longer one.

On visiting the bridge department of the road, the writer

found the bridge engineer in charge fully qualified to make detail drawings of bridges when the type and general dimensions had been fully specified, but quite unable to determine the economic type or its proper length. Custom had governed the choice in these matters, and as previously stated, the custom of different men differed by 400 to 500 per cent. The absurdity of the situation then loomed up strongly when it appeared that steel bridges had been installed where earth embankments should have been, and an amusing feature of the situation was, that after choosing improper types and general proportions costing three to four times more than needed, the engineering department was then calculating stresses to decimals and endeavoring to reduce the cost by saving in details.

The conclusion at once became evident that while engineering schools were turning out men who could calculate stresses and detail structures with exactitude, there was need for a wider knowledge of the primary essentials.

One of the most important duties of a bridge engineer is the selection of economic types and the determination of general dimensions and design, but too often this is fixed by custom, guess or judgment. The cost of a bridge is affected most of all by its form and proportions, and sizes which are too large and excessive are often specified when smaller ones with embankments at the ends would leave ample space for the highest floods. The difference in cost between a 500-foot and a 300-foot bridge might be $15,000 to $20,000, and if the greater length is specified where the shorter one would do, the figures given represent the loss which might have been saved by greater engineering knowledge. Whereas, after specifying a 500-foot bridge, the greatest saving which an expert detailer could make would not exceed $4,000 to $5,000, or only one quarter of the saving which would result from careful and competent preliminary investigations.

A SHORT COURSE IN RAILWAY CIVIL ENGINEERING.

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In reviewing the published proceedings of the Society for the Promotion of Engineering Education, one is struck with the paucity of discussion on subjects pertaining to railroad engineering, since two papers with brief comments on each constitute the sum total of such matter. This condition surely does not obtain because of a failure to appreciate the importance of the subject, for both Professor Allen and Professor Nagle in the above mentioned contributions point out the need of proper education in railroad affairs, particularly in regard to maintenance and operation. Notwithstanding this fact, there still exists a dearth of published information concerning what is actually being attempted and accomplished in the technical schools of the country. With a view, therefore, to drawing out discussion and criticism the writer is moved to offer a brief outline of the courses offered in railway engineering which constitute a part of the regular civil engineering course at the University of Colorado. Not with the idea that the arrangement described is novel in any way or superior to corresponding courses offered at other institutions is this contribution made, but rather with the hope that through criticism and suggestion the best course in this very important subject may be formulated.

Before giving the details of this subject, however, a few remarks concerning the requirements of railroad engineering in general may not be amiss.

Since the days of the "Erie War," and the time when directors' meetings were in part occupied by balloting for

train conductors, as a perusal of the minutes of early meetings of the Michigan Central Board will show, and the time when trains "put up" for the night as had been the custom of the old stage coach, and the time when two men constituted the crew of a passenger train, the fireman handling the baggage and applying the brakes and the engineman collecting the fares, railroad business has indeed made progress. Railroad engineering, keeping pace with other branches of the industry, has also advanced and no longer means the location at record speed of through lines several hundred miles in length, much of which might be done in a more or less haphazard manner. The period of development has arrived when the problems to be solved are founded on principles of economy, safety and efficiency of service. The present day situation involves nice distinctions in matters of location, chiefly on relatively short lines; improvement of existing locations by means of cut-offs and re-locations; elimination of curvature and distance and reduction of ruling gradient; double tracking; track elevation in cities; securing better passenger terminal facilities by the erection of large and attractive passenger stations, and, especially in the large cities, adjusting such arrangements to local transportation; the improvement of train yards and terminal accessories in order to facilitate the rapid handling of freight; the installation of interlocking devices and block signals and other appliances to promote safety, not only of patrons but of employees as well; improvement of road-bed and a study of the track considered as a composite structure and related questions arising from the consideration of economy in maintenance. In fact the problems of railroad engineering in every department have become so complex that they necessitate the application of scientific method in their treatment, and earlier methods employed, involving as they did a large factor of guessing and uncertainty, have had to give way to more exact calculations. In this connection, the modern technical school is playing a part, by fitting young men for railroad employment, by correlating the experience of various railroads and,

by means of their laboratories, they actually add in many cases information which does not rise to the surface in the practical conduct of railroad affairs.

The gradual change in the character of the personnel of the engineering corps and of the administrative officers reveals a certain relationship between technical schools and practical railroad matters. Even a casual observing of the lists of membership of the American Railway Engineering Association discloses the fact that a very large number of the operating officers are members of this engineering association and, indeed, not a small number of them are members of the American Society of Civil Engineers. In the case of several railroads, notably the Northern Pacific, the Pennsylvania and the Wabash, the president is a member of the latter society. Moreover, many of the men from the operating department of railroads are graduates of engineering schools. The transition of the superintendent of bridges and buildings from the character of skilled carpenter and capable foreman to the dignity of an engineer and the fact that the division engineer is no longer a superior section foreman are further indications of progress. In all of these places, one finds men for the most part who have had a technical education. Only a few years ago, many if not most of the chief engineers of railroads had never pursued an engineering course in college as a part of their preparation, while at present the vast majority of chief engineers have had such training. As more and more through the employment of such men in positions of authority a fuller appreciation of the value and at the same time the limitations of technical education is realized, the demand for men fitted in this way will increase.

Doubtless the most vital engineering problem confronting the railroads at this time is the improvement of terminal facilities. After trains are once made up and started on the road, there is comparatively little difficulty in handling them over the tracks as constructed, the delay being principally in the terminals. It is apparent upon a moment's reflection that the roadway is in actual service but a small fraction of

the time throughout the year, that during perhaps ninety-five per cent. of the time, no use whatever is being made of this property in which much capital has been invested with the consequent outlay of interest and depreciation. Better terminal facilities enabling a fuller use of the line and a more economically and more consistently balanced operation as a whole, would obviously greatly increase the efficiency of the system. That a Boston lawyer, although evidently a man with a greater gift of eloquence than of specific information on the subject, could startle the public by the assertion that railroads could save a million dollars a day by improved methods of operation, is almost incredible, yet it is true. The present-day problems are those involving a careful weighing of matters concerning economic expenditures.

Wellington's "Economic Theory of Railroad Location" well represents the railroad situation of his day—twenty or thirty years ago. While this book is admirably written from the view point of method of treatment and has served a useful purpose in promoting scientific railroad engineering and will always remain a classic contribution on the subject, yet the extraordinary development of rolling stock, the growth of combinations and mergers, the fierceness of modern competition and many other unforeseen elements have antequated many of his conclusions. The development of the Union Pacific is typical to a certain extent of the changed situation everywhere. Mr. Wellington says,* "There are several hundred miles of the Union Pacific Railroad on which there is practically no break either of line or grade, but trains rise into view on the horizon as at sea. As a very natural consequence, it was at one time, and perhaps in a less degree is yet, the custom to operate the road in almost entire indifference to time-tables or train orders. When an opposing train 'hove in sight' both made for the passing point which happened to be nearest between them, and if their ideas as to where this point was, happened to be different, one or the other would back out."

* "Economic Theory," p. 255.

While the above remarks are drawn almost entirely from the realm of practical railroading and suggest the changed nature of that field, they are intended to indicate at the same time the province of the technical schools which offer courses in railroad engineering in any form.

Before beginning a description of the courses offered at the University of Colorado, attention should be called to a few notions underlying the formation of the curriculum at that institution. In the first place, a very large part of a railroad engineer's work will relate to surveys of right of way and of station grounds, bridge surveys, design and construction of bridges and other framed structures, bridge substructure, foundations, culverts, water service, tunnels, etc., matters which are more or less adequately covered in other portions of the regular course of study in the civil engineering department, consequently for the most part, a course highly differentiated from the regular civil engineering course does not appear to be absolutely required to meet the needs of the situation. For this reason, certain options permitted in the senior year are practically the only variation from the regular schedule in several institutions where special instruction in railroad engineering is provided to accommodate those students who early determine to enter this field as a life work. In the second place, the arrangement of field work and class study must be such that these two branches will be mutually beneficial and at the same time not be incompatible with other subjects which are studied simultaneously. For example, field work, drafting periods and laboratory exercises cannot well occur during the same semester and likewise the heavier mathematical phases of the subject should not be concurrent with mechanics and other mathematical subjects. In other words, the practical arrangement of schedules suggests allowing some variety of study in any particular semester.

The courses in railroad engineering at the University of Colorado have been formulated in accordance with the above ideas so far as has been practicable.

In the second semester of the sophomore year, the geomet-

rical curves used in track construction are studied, including simple, compound, reverse and vertical curves and their applications. Inasmuch as this is chiefly a study of the geometry of the circle, it is largely a class room exercise involving the solution of problems illustrating the text and supplemented by staking out a curve of each type in the field. One credit hour is allowed for this course.

During the first semester of the junior year, a three-hour course in lecture and recitation and a two-hour course in field work are given, and during the second semester, a further two-hour lecture and recitation course is offered. These will be described separately.

Lecture and Recitation Course.—The work of this course consists of studies of the mathematical relations of switches, turnouts, Y-tracks, etc., the transition spiral as developed by Talbot; methods of setting slope stakes and cross sectioning; methods of computing earthwork, a study of haul and the mass diagram; economics of railroad location as treated in Webb's "Economics of Railroad Construction" and supplementary notes by the instructor. This is followed by a study of track construction and maintenance with Tratman's "Track and Trackwork" as a text. In order to make the matters concerning track more intelligible to the student, he is required to make an examination of some railroad and to submit a report as to that road's practise touching a number of points which are given him in outline in mimeographed form. This work is usually done by the student while on his vacation at the Christmas holidays. No attempt is made to have the list of topics include yard construction, for which other provision is made. The following is the list usually furnished the student:

A. Right of Way and Roadway.
1. Width of right of way.
2. Right of way fences.
3. Width of subgrade.
   (*a*) In cut.
   (*b*) On embankment.

4. Drainage.
5. Double or single track.
6. Side slopes in cut and on embankment.
7. Width of gage.

B. Track.

(*a*) Rails.

1. Section used.
2. Weight of rail.
3. Where manufactured.
4. Wear on curves.
5. Scale of worn metal on top of rail.
6. Interchange of inner and outer rails on curves.

(*b*) Ties.

1. Kind of timber used as ties.
2. Size of ties. Sawed or hewed.
3. Number of ties per rail length.
4. Per cent. of rail length resting on the ties.
5. Method of dating ties.
6. Method of piling ties on right of way.
7. Are the ties treated? Process?
8. Condition of ties.
   Crushing under rail.
   Decay.

(*c*) Ballast.

1. Kind of ballast.
2. Depth under tie.
3. Shape at shoulder.
4. Amount of ballast per mile of track.

(*d*) Rail fastenings.

1. Kind of fastening.
2. Use of tie plates.
3. Number of spikes per tie.
   On tangent.
   On curves.
4. Use of rail braces.

(*e*) Joints.

1. Kind of joint used.
2. Description of angle bar.
3. Use of nut locks.
4. Evidences of sag at joints.

(*f*) Miscellaneous.

1. Evidence of creeping of rails.
2. General appearance of track and roadway.
3. Superelevation on curves.

C. Right of Way Structures.
1. Cattle guards.
2. Mile posts.
3. Crossing signs.
4. Snow fences.
5. Highway crossings.
6. Miscellaneous track signs.

D. Turnouts.
1. Kind and number of frog.
   (*a*) Main line.
   (*b*) Branch lines.
2. Length of switch rail.
3. Length of guard rail.
4. Distance of sidings from main line.
5. Use of derails.

E. Narrow Gage.
1. Width of gage.
2. Method of turnout when combined with standard gage.
3. Spacing of ties.

Accompanying the instruction in this course as above outlined, a series of problems is given similar to those listed below. For the most part these represent practical matters which are not discussed in the texts, but they are in no sense intended to be *problems* for the practising engineer.

Frogs and Switches.

1. Two main line tracks are 14 ft. apart center to center. Compute the distance between frog points for a No. 10 cross-over.

2. With a 5½ in. throw and an 18 ft. switch rail, what will be the length of the practical lead?

3. How near to the point of frog of a No. 8 turnout can a box car which is 9 ft. 6 in. wide be left standing without fouling a car of the same width on the main line?

4. A ladder track makes an angle of 20° with the main line. Using a No. 10 turnout and compounding with an 8° curve at the point of frog, compute the distance from the point of intersection to the point of frog. Compute the length of the 8° curve.

5. If the body tracks which turn out from the above ladder track are 24 ft. centers, what will be the distance between frog points along the ladder track, No. 8 frogs being used?

CURVES.

1. Given a central angle of 42° and two tangent lengths of 218 and 462 ft. respectively, to compound the curve.

2. To find the degree of curve of a simple curve by means of a transit and tape measurement on the track.

3. What is the length of chord such that the midordinate in inches is equal to the degree of curve?

4. Given a transition spiral on a curve concerning which none of the properties are known. To find the rate of spiral, the P.S., the length of spiral and the P.C.C.

5. Given a simple 6° curve joining tangents which make an angle of 54° with each other. Required to throw out the middle of the curve 2.5 ft. and to compound the curve, keeping the P.C. and the P.T. unchanged in position.

LOCATION.

1. To project a location across a topographic map.

2. To estimate the earthwork for a projected line.

3. To locate the toe of a fill and top of an embankment on a contoured map.

4. To locate a culvert on a contoured map so that the amount of excavation may be a minimum.

5. To find the length of the masonry of a culvert of a given height when placed in an embankment as shown on a contoured map.

Field Work.—The field work connected with the instruction in railroads consists in locating a line in the field about two and a half miles long, making the preliminary surveys, a paper location and the final location. In order to obtain as long a line as possible, the different sections of the class taking the course are allowed to work on the same project. After the final location is complete, the line is divided into residencies and about three men are assigned to a residency. They are required to cross section and set slope stakes on their residency, make surveys for culverts, determining the drainage area, water way necessary, etc., compute the earthwork, and make a complete estimate of the cost of construction of the track. These squads then exchange notes so that each student has an estimate for the entire line. The class makes a large contour map of the work on a scale of 1 in. = 100 ft. and each student makes a small map of the entire line on the scale of 1 in. = 500 ft. and he also makes separate profiles, mass diagrams, etc.

The attention of the class is called to the importance of studying location while riding on trains, of observing how the railroad attains elevation by development, how it follows ridges and creeps up valleys, and the relation in all respects to the topography which it traverses.

The amount of work that can be accomplished in the field depends entirely upon the definiteness with which the instructor plans the program. If he has a very definite task for each man each day so that no time will be wasted in beginning operations after arriving in the field, nearly twice as much can be accomplished as can be done when the instructor gives no time to the project except when with the class. In the classes at the University of Colorado, the instructor virtually performs the duties of the locating engineer and the work is conducted much as it might be done from a division engineer's office.

Second Semester Course.—As stated above, during the second semester of the junior year, a two-hour course is given. This consists of a study of yards and terminals and block signals, using Droege's book on "Freight Terminals and Trains" as a text supplemented by notes by the instructor. The ordinary layouts as well as special arrangement of yards are studied together with the different methods of switching, the making up of trains, special terminal railways and clearing yards, and accessory terminal structures including ash pits, coaling stations, ice houses, freight houses, transfer platforms, train sheds, water service, etc. To facilitate this study, the department has made a collection of blue print layouts of different yards and terminals which have been very generously furnished by engineers of various roads. Some time is also devoted to interlockers and block signals. This course with those described above makes a total of eight credit hours devoted to railroad engineering directly in the regular civil engineering schedule.

Graduate Study.—The department of civil engineering also offers graduate courses in modern problems in railroad location, considering such questions as cut-offs, the economic justi-

fication of double track, re-location with the reduction of grades, curvature and distance; water front terminals; valuation of railroad properties. These courses have in the past been given to graduate students with occasional senior students who happened to have time enough to do the work. Special assignments involving studies in the reports of the Interstate Commerce Commission and in technical literature constitute much of the work.

In the undergraduate courses as outlined above, the teaching of practical experience primarily is not intended, for the writer appreciates fully the futility of such an attempt and realizes that the student after beginning actual railroad work will learn more practise in a few months than the school could teach him in his entire four years. Moreover, a student can not afford to devote the time while in school to learning the practical tricks of railroad work but he must count on gaining his practical experience during vacations and after he has graduated. For this reason, only questions of a theoretical nature and underlying principles are discussed in the main, but an attempt is made to develop in the student systematic methods of attacking problems so that he may not be at a loss entirely as to how to proceed in whatever he may be called upon to undertake. The imparting of practical skill and training is therefore left for the apprenticeship course of the railroad, or whatever corresponds to it. About fifty railroads of the United States offer some form of apprenticeship courses, and by means of them, the student who has a desire to cast his lot with the railroads will find the opportunity he wishes.

Even if it were possible to teach the best practice during a student's course, in a very few years, such practice would be out of date. One of the chief advantages of a thoroughgoing technical education in the fundamentals is the versatility which it bestows. The graduate is able to adapt himself to new conditions and new appliances, for although the particular application may be novel, the underlying principles relate back to the mathematics and mechanics of the class room.

In order that the most may be made of the student's time

and effort, the course should be arranged with greatest care. The question may well arise as to the proper distribution of time between class room exercises and field work. The writer is of the opinion that much time can be easily wasted in the field, and for that reason, would make it secondary to class room instruction. Many other similar questions may arise. It is with the hope of stimulating discussion on this very important subject that the above contribution is offered.

FUNDAMENTALS OF EDUCATION AND THE SPHERICAL-WANT SYSTEM.*

BY F. W. SPRINGER,

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X.

French, German, and American Schools and Students. United States Schools.

Higher education and our present educational ideals had their origin about 1650. They were inaugurated by a people that had suffered much from religious persecution. The conviction of these early English Puritans, that it was the duty of the State to provide free education to every citizen and to eliminate every political and ecclesiastical control from the schools, is still firmly held by our people of to-day.

Puritanism still rules this country because of the educational impetus given by a few thousand solid citizens in 1650.

French Schools.

The present school system of France was directly the result of an investigation following the calamity of 1870. The committee that was appointed concluded that the military strength of the country would be greatly increased if a larger percentage of the soldiers could read and write, and that the cause of the great disaster was due directly to lack of unanimity through lack of education.

War as an educator of races and nations certainly in this as in most other cases takes first place in the school of experience which is about the only school that can make all

* Continued from the April BULLETIN, p. 561.

members of a race think desperately hard about the same problem of life at the same time.

The immediate advantage of a war course generally goes to the people who are the best prepared in every way, cleverest and most numerous. The Germans won the war and the French paid for being taught that their system was poor. In this case, as in others, the cost of tuition or experience was extremely high but it was perhaps worth the price paid, and will, no doubt, continue to be of value as long as interest payments on this old war debt must be cared for.

The Franco-German war is an example of the fact that a nation which is not prepared to compete industrially and to wage or to prevent war when its own interests are at stake is prepared to die or to pay the bills when its interests are the concern of a better prepared nation.

On paper, the French school plan seems to be an excellent one, but France is even farther behind Germany than we are. The French are bankers and the Germans and the Americans are manufacturers. This may explain the difference.

The French system is somewhat like that of the United States in the grades, since the larger part of the pupils attend the public schools till 10 to 14 years of age. The upper courses are more like the German gymnasium, and the traditions and methods of the universities are, in general, much like those of Germany. The fact that the government school system is behind in engineering and trade schools is clearly shown by the large number of private boarding schools of all kinds.

German Schools.

The modern, advanced German schools had their origin in schools for preparing young men for the ministry. The scope of these classical-religious schools was gradually extended to include preparation for other walks in life, but the classics were jealously adhered to so that a knowledge of Latin and Greek came to be the ear marks of a scholar in Germany. But, commercial and military necessity forced first the introduction of modern languages as equal to the classics and

later, or within the last twenty-five years, engineering and manual training have reached almost an educational equality with the older courses.

It is easy to account for the persistence of Latin in the American schools because such a large percentage of English, and especially technical English, is of Latin origin. This is even more the case in France. But, in the case of Germany, there appears to be no necessity for studying the classics except for the training and culture. The classics in Germany are going out of style, almost as much so as in the United States, and science, modern languages, and engineering have come into vogue.

The modern German school system is largely due to the foresight of a few German leaders who saw the necessity of education, and especially of technical education, if Germany wished to thrive in competition with the dense populations about her. The beginning of industrial training is said to have been made by the old Emperor Frederick who had a lathe secretly bought in England, rusted to look like old iron, and shipped in parts by different routes to Germany. One piece came around through Russia. This lathe was set up and loaned to various German manufacturers that they might copy it.

It is said that the origin of the phrase, "Made in Germany," was due to a law passed by England as a protection against imported cheap German goods of very poor quality. All such imports had to be stamped "Made in Germany." The Germans still use this stamp, but for a different reason, thanks to her technical school system.

A German representative visited the Philadelphia Centennial and reported back that the German exhibit in comparison with the others was "cheap and nasty," and that something would have to be done with the German industrial and technical schools. Germany has now the most effective school system in the world. Her life depends upon it, and a few governing leaders of a generation or so ago, who knew, are responsible for her success.

Germany has about 16,500 engineering college students, in eleven fine, large engineering colleges, and 1,700 engineering graduates per year for 65,000,000 people. There is also an increasing number of industrial school graduates in addition.

We need, of course, a relatively much larger number of engineers than the Germans because of the enormous amount of development work to be done in a much larger and newer country, with a larger and growing population.

Student Characteristics in France, Germany and America.

If an average German student were to take a university course in America, he would, no doubt, adopt many American mannerisms and ideas. He would, however, retain his German mental and physical characteristics. It is the same in the case of a French student.

American students abroad in Germany and France, even after a number of years, still remain and are recognized as Americans, whether their views about life are French or Puritan.

If we grant this great racial difference, it is seen that student life in America, France and Germany must necessarily be different, even though there were no other causes or differences.

The German race is very masculine in temperament. This is greatly increased by militarism. The French have the Latin or feminine intuitive temperament, made less so by the military environment.

The American stands between the other two in many ways, but would, with a military training, such as the German has, become perhaps even more rough-shod, energetic and assertive than his Teutonic cousin.

A German is never so German as when among Germans. This is even more so the case with the French. The racial characteristics and tendencies of an individual are stimulated when among his own people.

There is a greater difference, however, among these different classes of students than among the mature classes. Busi-

ness, society, etc., abroad, are much the same as here. It is true that, for example, in America, checks are used by nearly everyone, since the bank takes the risk in case of payment to the wrong person, while checks are not generally used abroad because the individual runs the risk. In society there are also slight differences, for example, in Germany the gentleman speaks first on meeting a lady. This sometimes causes some embarrassment to an American, because of his **habit** in America of waiting till recognized by the lady. On the whole, an educated American readily meets foreigners abroad on a common sense basis in business and society, without greater fear of making a break than a man of one class might make in another class of his own country.

Tradition, next to racial characteristics, plays an important rôle in student life abroad. The German student, if he belongs to a corps, fights duels and drinks beer. The duelling is still kept up, but within the last few years it is not compulsory to drink beer in the corps or fraternity meetings. Since the Kaiser announced that his health might be drunk in water, conventional beer drinking among students has fallen off.

It is said that this result followed tests made on a number of regiments, in which it was found that those which consumed no malt or spirituous liquors could out-march, outmaneuver, and out-shoot the others. It is admitted in Germany, that beer drinking, even in moderation, for a German, reduces the initiative and the capacity of a man—for work. Hence, the German mind has arrived slowly and surely, like a mental steam-roller, at the inevitable conclusion.

The student duelling is a bloody business, and to a foreigner, the bandaged faces of students and long red scars seem an advertisement of barbarism. It is, but perhaps we also are somewhat barbaric. The German and French students think American football is brutal, and that it ought to be stopped by law. Duelling among German students is a tradition arising from the old days when it was necessary for the young men of Germany to develop blood and iron for the battles of the Vaterland in its struggle for freedom.

The reason for permitting duelling today is because it develops steadfastness and courage. The scars on a man's face announce that he has had the nerve to stand up before "the long knife" (*das lange Messer*), and be slashed at by a very energetic and equally courageous opponent. The scars stand for nerve, and the boys and mature men are proud of them.

There are two kinds of duels, one is equivalent to a boxing match between members of two fraternities. Occasionally there is the other kind, in which a man is called out for some real or alleged insult. This sort occurs very seldom.

There are two opinions about duelling in Germany, just as there are two opinions about football in America. In the opinion of the writer, German duels, with their blood and scars have their place in Germany, just as football, with its victims, has its place in America. They both represent the strenuous contests in real life among the nations and individuals, and tend to fit the youth for them.

English sports have lately been introduced into Germany, names and all. This fact, together with the reduction in beer drinking by the students, will undoubtedly increase the capacity of Germany to do things in the next generation.

While the German is fighting duels, learning the English field sports, and chatting in his favorite *Lokal*, the American student is doing those things with which we are familiar. In some respects the American college student takes life more seriously than the German student, but the American high school student is far less serious than the Gymnasium boy.

While the French are taking up field sports to some extent, the student café life, and often *"en famille,"* seems to be most prominent among the French students.

Many a German student has *sein Verhältniss* and each one of quite a large percentage of French students has *sa petite femme*. This is a phase of student life that the American can understand only when in the *milieu*.

The more one sees of foreign students, the more one comes to believe that from our standpoint, at least, our college boys are pretty good boys. It is not the intention to say, however,

that American boys are better from our standpoint than the German boys are from the German standpoint, or the French from theirs.

In so far as morals go, there are several things that affect the situation. We have coëducation, puritanism and social freedom from childhood. Boys and girls are comrades from childhood here, on a basis not at all understood by Frenchmen or by Germans.

In France, even engaged couples of the better classes do not go out without chaperones. The lack of liberty on the part of the upper class young ladies is very much offset by the liberty taken by the student girl friends. Perhaps the average is about the same as with us.

The German and also the French boy, to some degree, is held in leash till he enters college, and then in the cultural courses, at least, he has full freedom and not much to worry about till he comes up for his degree. In America he is held accountable for his work every day. The college period abroad is one of orientation, and most of the boys orient.

The foreign engineering schools are different. The work demanded is so great that the boys must work out their salvation much the same as the American engineering student.

The stories one so commonly hears of French students usually apply to art students, many of whom, in Paris at least, are foreigners, including many Americans. The traditions of the old Roman revelries still persist in this class. The art environment in Paris is most certainly not adapted to fit American boys and girls to live under the puritanical code in America. American boys abroad generally adopt the customs and mode of living of the foreigners. The American girls, however, as a rule, remain and live strictly American, compelling foreign men whom they meet to adopt some Americanisms.

In comparing the morals of French, German and American students, we must not forget that puritanism here is the backbone of our code In making comparisons, it would be best to compare the results of those lines of conduct of each race

which the particular race considers correct, or at least unmoral, and not immoral. It must be admitted that a people that does things the people themselves think wrong degenerates.

French and German students undoubtedly do some things we think wrong, and that they think admissible from a broad point of view. We must judge each by the result and not condemn because a thing which would be bad for us must be bad for all other races. If we were to take the subject of drinking, for example, it would be impossible for the Americans to "drink" as do the French and Germans, because our boys wouldn't stop where the foreigners do.

The German corps student dons his funny little, highly-colored cap and fraternity ribbon or band; the extreme French art student affects wide corduroy trousers and a sash, a large tie, and a tumbled down hat or cap; while the excessive American college boy wears as much noise and color in the shape of clothes and shoes as he can find in the market.

German students, especially those in the engineering colleges, have, as a rule, larger views than the American students. The former are as much interested in opportunities in South America and Africa as in those at home. Our boys are not.

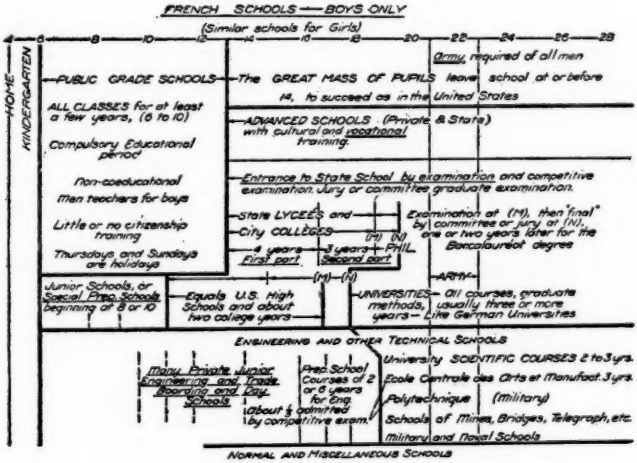
Comparison of the French, German and American School Systems.

The accompanying diagrams of the school systems of the above named countries have been made in order to learn, if possible, whether or not there are any holes in our system. The diagrams are believed to be sufficiently accurate for general comparisons.

The three countries mentioned have probably the best schools in the world. They are all Christian nations with the same general ideals and aims. They all teach the power of divine love and practice the use of force to insure their national and racial rights. All three school systems are controlled by the people, and are fairly, if not quite free from

class or sectarian influence. The primary object of all three systems is to make good citizens in the broad sense, to develop the country by high efficiency in commerce and manufactures, and to insure unanimity and effectiveness of action in national defense and offense.

A comparison of the above school systems shows some differences of interest to us, some of which we could adopt with profit.


FRENCH SCHOOLS — BOYS ONLY
(Similar schools for Girls)
4 6 8 10 12 14 16 18 20 22 24 26 28
HOME KINDERGARTEN
PUBLIC GRADE SCHOOLS
ALL CLASSES for at least a few years, (6 to 10)
Compulsory Educational period
Non-coeducational
Men teachers for boys
Little or no citizenship training
Thursdays and Sundays are holidays
Army required of all men
The GREAT MASS OF PUPILS leave school at or before 14, to succeed as in the United States
ADVANCED SCHOOLS (Private & State) with cultural and vocational training.
Entrance to State School by examination and competitive examination. Jury or committee graduate examination.
State LYCEES and City COLLEGES
4 years First part
3 years Second part
(A) PHIL.
(B)
Examination at (A), then "final" by committee or jury at (N), one or two years later for the Baccalaureat degree
ARTS
Junior Schools, or Secondary Prep. Schools beginning at 8 or 10
Equals U.S. High Schools and about two college years
UNIVERSITIES — All courses, graduate methods, usually three or more years — Like German Universities
ENGINEERING AND OTHER TECHNICAL SCHOOLS
Many Private Junior Engineering and Trade Boarding and Day Schools
Prep. School Courses of 2 or 3 years for Eng. Schools
About ½ admitted by competitive exam.
University SCIENTIFIC COURSES 2 to 3 yrs.
Ecole Centrale des Arts et Manufact. 3 yrs.
Polytechnique (Military)
Schools of Mines, Bridges, Telegraph, etc.
Military and Naval Schools
NORMAL AND MISCELLANEOUS SCHOOLS

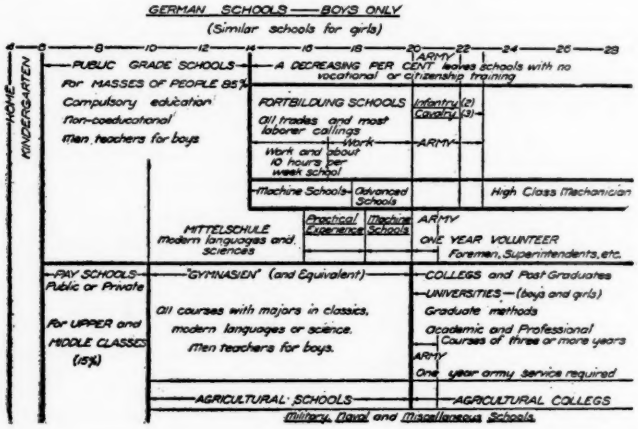
1. Splendid training for the great mass of people (eighty-five per cent.) in Germany between the ages of fourteen and eighteen, in citizenship and the trades. We have as yet little of this. The larger number of American pupils leave school at or before fourteen to make their way as best they may with no special training to fit them for any particular line of work.

2. Coëducation nearly everywhere in the United States, and very little in Germany and France between the age of six and twenty.

3. Both Germany and France have a central governmental school control while in the United States each state is a free

lance so far as education goes. The readiness to adopt new things, a spirit of emulation and sufficient funds have, however, offset to some extent the lack of organization among different state and city schools.

4. Military training is recognized as an active element in education, especially in Germany. We have none, and also very little training for political life by the application of the fundamental principles in selecting leaders in school life.

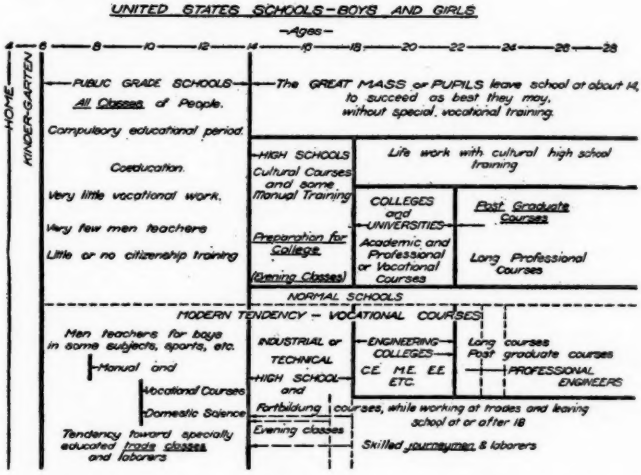


Equivalent military training may be introduced into our high schools and grades.

5. Militarism and military discipline permeate every walk of life abroad and not at all here. A French boy, and especially a German boy, lives in a military environment. The father, grandfather, uncles, neighbors, policemen, car conductors, men on the streets, and teachers are military trained men. Orders are given to be obeyed, not avoided. Laws are made to be applied, and there is, in Germany, less tendency to pay a large fee to a clever lawyer for finding a small hole in a law, than in the United States. The limits of society really limit actions in Germany; which partly explains the success

of the disciplinary or external-pressure teaching system in that country.

6. There are two classes of society in Germany, and to some extent also in France, the aristocracy and the general public. In the United States the distinction is almost wholly on a basis of ability. Usually this ability is rated on a basis of wealth, the common supposition being that a rich man is at least clever. The coming industrial training, however, appears to be the beginning of a distinctively two-class system; first in education, then in society.


UNITED STATES SCHOOLS—BOYS AND GIRLS
—Ages—
4 6 8 10 12 14 16 18 20 22 24 26 28
HOME
KINDER-GARTEN
PUBLIC GRADE SCHOOLS
All Classes of People.
Compulsory educational period.
Coeducation.
Very little vocational work.
Very few men teachers
Little or no citizenship training
The GREAT MASS of PUPILS leave school at about 14, to succeed as best they may, without special, vocational training.
HIGH SCHOOLS
Cultural Courses and some Manual Training
Life work with cultural high school training
COLLEGES and UNIVERSITIES
Post Graduate Courses
Preparation for College
(Evening Classes)
Academic and Professional or Vocational Courses
Long Professional Courses
NORMAL SCHOOLS
MODERN TENDENCY — VOCATIONAL COURSES
Men teachers for boys in some subjects, sports, etc.
Manual and
Vocational Courses
Domestic Science
INDUSTRIAL or TECHNICAL
HIGH SCHOOL and
Fortbildung
Evening classes
ENGINEERING COLLEGES
C.E. M.E. E.E. ETC.
Long courses
Post graduate courses
PROFESSIONAL ENGINEERS
courses, while working at trades and leaving school at or after 18
Tendency toward specially educated trade classes and laborers
Skilled journeymen & laborers

7. Tradition is seen everywhere abroad, while here we are making tradition.

8. The boys are first in family life there, while the girls occupy some of the foreground here.

9. German boys are held down very closely to disciplined hard school work till twenty, with few sports. The contrary is true with us.

10. University students in Germany and France have the greatest liberty. The reckoning time comes with the jury type of examinations at the end of the college course.

11. While the German boys are held very closely to the straight and narrow path till about twenty, those who enter universities often *bummeln* for a year or so with the idea of orienting their ideas of life. According to Bismarck, fifty per cent. go to the devil, twenty-five per cent. are second class, and twenty-five per cent. rule. The latter keep Germany at the front, and on top. After having been well trained, the boys are then given a chance to survive or perish, before marriage.

12. Germany gets about the best teachers and professors possible by competitive examinations and exacting competition. Here, in a new country, with so many opportunities, it often depends upon who happens to be handy, or who applies for a position. In the United States the salaries offered men teachers are relatively unattractive. The results are as might be expected.

13. The German, and also the French professor does a little teaching, mostly lecture work, much study and much research work.

14. The universities and technical colleges of Germany reach their climax in their research departments, which supply much of the teaching information, and which directly or indirectly enable certain German manufacturing and technical fields to lead the world.

15. In the United States, we are wealthy, partly, at least, because of, and at the expense of, our natural resources. Germany is prosperous because of industry and training.

16. A German gymnasium graduate could undoubtedly compare favorably with the average American college graduate in knowledge of facts.

17. The German engineering schools are quite like the United States schools in many respects. The laboratory work and its administration is practically the same as with us. The class work is taught, however, by the lecture or graduate methods. Attendance in class is not usually compulsory.

18. Competitive examinations are held in France, for admission into professional and technical schools, like those for

entrance to our military academies, thus limiting higher education to the fit. An extension of the duties of our state high school boards would approximate this.

19. Opportunities are given the sons of poor families to pass competitive examinations, to obtain not only free tuition, but a sum sufficient for all their needs while in school, because the making of many a great leader may be found in the lower walks of life.

20. Final examinations are given by others than those who have taught the students. There is a jury or committee examination for all degrees.

21. Examinations come at the end of each two years in German engineering schools.

22. The preliminary training for engineering as well as other university students is superior to that in the United States, since the gymnasium and equivalent schools give courses full of work and discipline and are taught by military trained men teachers.

23. The German preparatory school boys work more hours per day, and more weeks per year than do our high school boys.

24. Illiteracy in Germany is a vanishing per cent. It is probably 7.7 per cent. in the United States, owing to the presence of certain foreign elements. France claims a lower percentage of illiteracy than that of the United States.

Germany with her Volksschulen, Bezirksschulen, Buergerschulen, (8 grades); Hoehere Buergerschulen, Hoehere Toechterschulen, (10); Realschulen. Realprogymnasien, Progymnasien (4); Oberrealschulen, Realgymnasien, Gymnasien (3); Graduate University system and Research Laboratories; and "57 varieties" of Higher and Intermediate and Trade Technische Schulen, has solved, and is still solving, her educational problem well, and under the disadvantages, or advantages, of a double social system.

The difference in temperament, climate, natural environment, competition, resources, density of population, tradition, etc., makes our school problem a special one. At best we can

only find suggestive ideas abroad to try out here. **Each people must make its own educational system to correspond with its own ideals, environment and resources.**

We are a blend of the restless or energetic elements from abroad. We have within ourselves the stimuli of dual racial instincts. Our climate is stimulating; our natural resources are, at present, very great. The spirit of wanting to get for one's self more than he actually needs is in the air. The environmental influence in America is very effective as may be seen by its action upon immigrants.

We have had several hundred years of American freedom and while the right to vote is now held cheaply because it is inherited, and taken as a matter of course, because a living is yet easy to make, while the majority are insisting that our country remain a public grab bag of opportunity, we are, nevertheless, a true liberty loving and demanding people, and need only the proper citizenship training to become efficient politically, combined with the proper technical training to become efficient industrially.

We need not look to Germany, or to any other country, for a ready-made solution of our pressing school problem. It is our problem, and it is for the American public to put on the pressure that will induce educators to seek the solution.

(To be concluded by "Modern Trend and Science.")

THE ANNUAL INSPECTION TRIP OF THE UNIVERSITY OF COLORADO.

BY C. C. WILLIAMS,

Assistant Professor of Civil Engineering, University of Colorado.

The annual inspection trip for the year 1913 occurred during the week March 17 to 22 and was in every way a very successful undertaking. Ninety students, accompanied by the dean of the college of engineering, two professors, two assistant professors and three instructors constituted the party. All of the senior and junior classes in all of the departments of engineering are required to make such a trip each year, consequently, each student goes on two, one during his junior year and one during his senior year. The itinerary alternates between what is known as the "long trip" and the "short trip," the former being the one for this year and embraces some of the more distant points of the state while the latter covers Denver and nearby works of interest. Colorado is peculiarly an engineering state, consequently these trips are of unusual value because of the variety of works visited. These include mines, smelters, structures, irrigation projects, hydro-electric plants, power plants, railroad terminals, and many others.

A few specific items included in this itinerary may be mentioned. At Colorado Springs, the Manitou hydro-electric plant was visited. This plant uses the city water supply coming from Pike's Peak for the development of power. The static head is 2,480 feet and under working conditions the head is 2,250 feet. The steel works of the Colorado Fuel and Iron Company were the chief object of interest at Pueblo, although other matters such as the pumping plant, power station, water purification works, bridges, etc., did not pass unnoticed. An afternoon was spent in studying the Portland

cement works at Portland. Here unlimited quantities of materials are available for the manufacture of cement and the output is controlled only by the demand. At Shoshone, the hydro-electric plant of the Central Colorado Power Company was visited. The water is taken from the Grand River and is used under a head of 170 feet. The fall of this river is over a hundred feet to the mile, consequently the plant might be duplicated along the river every two or three miles. This plant is connected with the Boulder Cañon Plant, located about four miles from the University, which operates under 1,850 feet of head and is designed to carry the peak of the load. At Grand Junction irrigation works and some minor works occupied the attention of the party. The hydro-pumping plants of the Mesa County, the Palisade and the Orchard Mesa irrigation projects near the town of Palisade were included in the itinerary. These are low-head plants, the first two operating at about twenty feet head and the latter at sixty-five feet. At Leadville the smelters, mines and power plant were on the list of inspection. Not the least instructive feature observed was the study of railroad location while crossing the mountains and the operation of Busk tunnel on the Colorado Midland R. R. This tunnel is two miles long and is operated by means of the "staff system" in addition to the regular train orders.

During the last three days of the trip, when much of the time was spent in brief visits at scattered places, the party had a special train consisting of three tourist cars, a dining car and a day coach. In all about 850 miles were traveled; the cost per student averaged about $26.00 and ranged from about $21.00 up; and the time occupied was from 6:20 A.M. Monday to 10:30 P.M. Saturday.

COLLEGE NEWS.

Worcester Polytechnic Institute.—S. E. Balcom, Instructor in Management of Engines and Boilers at the Institute, addressed the Newburyport, Mass., branch of the National Association of Stationary Engineers, February 27, on "Steam Heating."—C. C. Couert, District Engineer of the United States Geological Survey, was the speaker at the regular meeting of the Civil Engineering Society held last month. His subject was "Stream Gaging." The subject was fully illustrated by lantern slides.—The Department of Civil Engineering has recently received a set of the reports of Connecticut State Board of Health, from 1895 to date.

The University of Maine.—Prof. W. E. Barrows, of the Department of Electrical Engineering, is giving a new two-hour course on Electric Power Plants, taking up the design of electric stations and systems of operation. Instead of the course in Drafting-Room Methods being prescribed for electrical engineering students option is now allowed between that course and one on Hydraulic Machinery offered by the Department of Mechanical Engineering. Thus the student, by taking advantage of this option, obtains a complete course in hydro-electric engineering, including the prescribed work in hydraulics and the above mentioned new course on electric power-plants.

Harvard University.—Work on the new $60,000 electrical laboratory will begin early in the spring. This building which is an anonymous gift to the University will be built between the Jefferson Physical Laboratory and Peirce Hall.

Stevens Institute of Technology.—On March 17 the senior class went on its annual "long trip" conducted by Prof. A. F. Ganz. This trip, called "long" to distinguish it from a number of shorter excursions not so far afield, gives the students an opportunity to inspect important power plants and manu-

facturing establishments. A carefully arranged itinerary made it possible to visit, in the course of ten days, the works of the N. Y. Edison Co. in New York, the General Electric and American Locomotive Companies in Schenectady, the Niagara Falls Power, International Acheson Graphite, Hydraulic Power, International Paper, Shredded Wheat Biscuit, Ontario Power and Toronto Power Companies at Niagara Falls, the American Steel and Wire Company in Donora, the Carnegie Steel, Westinghouse Machine, Westinghouse Electric and Manufacturing Companies in Pittsburgh, the National Tube Company in McKeesport, and the Bureau of Standards in Washington. It happened, but not without premeditation, that the party arrived in Schenectady in time to attend the annual banquet of the Schenectady Stevens Club, at which Dr. A. C. Humphreys of the Stevens Institute of Technology and Dr. P. C. Ricketts of Renssalaer Polytechnic Institute were guests. In Pittsburgh also the students were entertained by the local Stevens Club at a dinner held in the University Club.—The annual dinner of the Alumni Association, held February 14, took the form of a testimonial to Dr. Humphreys on the tenth anniversary of his inauguration as president of the Institute. The regard of the alumni was evidenced by the presentation of a model of the recently acquired Stevens Castle.

University of Utah, State School of Mines.—The State legislature has provided for the establishment of a metallurgical research department. The purpose of the department, the law says, is "to conduct experiments and researches, either alone or in coöperation with the National Bureau of Mines and other agencies, with a view of finding ways and methods of profitably treating low grade ores, of securing a higher percentage of extraction of metals from their ores, and of obtaining other information that shall have for its object the benefit of the mining industry," etc. The department is to be in charge of a new man, the most competent metallurgical engineer obtainable, who will have as assistants several graduate mining and metallurgical engineers. The head of the

department is to have no class room work but is to be free to devote his entire time to research work. The authorities of the School are anxious that the new department shall be entirely successful, and they are willing therefore to lend every possible assistance.

Lehigh University.—The residuary estate of the late John Fritz amounting to about $150,000 is left to the University. This money will be used primarily as a fund for the maintenance of the Fritz Engineering and Testing Laboratory.—The University has also received from Mr. C. L. Taylor, of Pittsburgh, money for a gymnasium and a stadium.

University of Minnesota, College of Engineering.—Dean Francis C. Shenehon, of the College of Engineering, has recently been called, by the government, to testify in a hearing of the Chicago Drainage Canal Case which was appealed by the State of Illinois after former Secretary of War, Henry L. Stimson had made an adverse decision. Dean Shenehon was appointed as a hydraulic expert for the government when it began an action to prevent Chicago and the state of Illinois from using the water of Lake Michigan for drainage purposes, and he has been one of the principal witnesses of the government since that time. The case is one of much importance and the final decision will be of great interest both in the domains of engineering and of federal control.—The annual banquet of the alumni, former students and faculty of the College of Engineering, was held Thursday evening, April 3, in the new Main Engineering Building. President Vincent was the guest and principal speaker.—The local Society is anticipating a very pleasant occasion when the annual meeting of The Society for the Promotion of Engineering Education takes place in June with it as host.—During the week of March 23, the Minnesota School of Agriculture celebrated the twenty-fifth anniversary of its founding. It has had a very interesting development and has done splendid work during this quarter century. It has proved its great usefulness to the State in many ways, and enters upon its future with every promise of greater service.

SECTION II

PAPERS FORMING A PART OF THE PROCEEDINGS OF THE SOCIETY.

SUMMER WORK IN INDUSTRIAL PURSUITS FOR STUDENTS OF ENGINEERING.*

BY F. P. McKIBBEN,

Professor of Civil Engineering, Lehigh University.

Should engineering students of technical schools and colleges continue to have summer vacations of from three to four months? If so, how should these vacations be utilized; in work or in play? To the first question most colleges would apparently answer in the affirmative, for practically all schools in the United States give vacations during the summer months. It is probably also the concensus of opinion that these vacations should be utilized by the students towards some profitable end, and should not be wasted, but there are apparently few schools that make systematic effort to find employment for anything like all of their students during the summer recesses. The University of Cincinnati has adopted the coöperative system by which students in civil, chemical, electrical, mechanical, and metallurgical engineering spend alternate weeks in college and in neighboring industrial establishments during eleven months of the year, leaving one month for recreation. While these students are employed in the manufacturing plants they are under the instruction of university teachers and the system is therefore essentially one of instruction for eleven months out of the twelve. Their students in civil engineering spend eight months of each year under this alternate week scheme and also are employed three months on a prominent western railroad where they receive instruction from railroad authorities.

The University of Pittsburgh has adopted a modified arrangement of the Cincinnati plan in that its students are

* Paper to be read at the Minneapolis Meeting of the Society, June 24–26, 1913.

required to spend three months out of every twelve in some industrial establishment. Both of these schemes are really extensions of the laboratory method of instruction, the laboratory in these cases being a commercial plant in which the student sees operations carried on in a large way. The Worcester Polytechnic Institute has for years done something of a similar nature for some of its engineering students who are given instruction in the university shop, wherein capable machinists, foundrymen and other workmen are engaged in manufacturing certain metal products which are afterward sold by the Institute. The students thus see manufacturing work carried on, but of course not under real commercial conditions. Here is another attempt to give the student some actual contact with the commercial world, but as this is given during the college year along with the academic work it is only a modified form of the usual method of teaching shop work in college shops.

Some schools utilize a portion of each summer for surveying or work of a similar nature which can best be done in a concentrated form, but in such cases only a portion of the summer is thus taken up. For example, civil engineering students at Lehigh University spend one month in surveying at the close of the junior year and students in some other departments of the university spend some time in the shops of the Bethlehem Steel Company under the guidance of university instructors. It is seen, therefore, that in most institutions the students are given vacations ranging from two to four months. It would be interesting to know how extensively summer work is engaged in by the students of technical schools and colleges. Now and then isolated attempts are made to get at the facts but no concerted action of any consequence has ever taken place. The civil engineering department of Lehigh University in October, 1912, collected data from the sophomore, junior, and senior classes as to the kind of work which the members of these classes did during the preceding summer and as to their earnings for such services. The accompanying table shows the summary. It indicates that out of a total of 98 men in the sophomore, junior, and senior classes, 76 worked to a greater

EARNINGS OF CIVIL ENGINEERING STUDENTS OF LEHIGH UNIVERSITY DURING SUMMER OF 1912.

		Seniors Months.	Juniors Months.	Sophomores Months.	Totals Months.
Kinds of work	Municipal engineering	3	2½	9½	14½
	Machine shop	2½	—	5½	8
	Engineering office work	13⅓	6¼	4½	23 1/12
	Non-engineering office work	3	5	13½	21½
	Construction	5½	8¾	6½	20¾
	Railroad engineering	8½	15 7/12	6	30 1/12
	Surveying	11 11/12	3⅓	1⅓	16 1/12
	Highway engineering	6	2	6½	14½
	Hydraulic engineering	2¼	—	—	2¼
	Farming	2	—	5½	7½
	Barbering	2	—	—	2
	Canvassing	—	—	1	1
For students who worked	Total number of months employed	60¼	43 7/12	59½	163¼
	Number of men reporting	41	27	30	98
	Number of men reporting having worked	30	20	26	76
	Average number of months employed for all men reporting	1.5	1.6	1.9	1.6
	Average number of months employed	2.0	2.2	2.3	2.1
	Total earnings for summer, not including traveling or other similar expenses	$3,524.03	$2,282.25	$2,566.80	$8,373.08
	Average earnings per summer per man, not including traveling or other similar expenses	$ 117.46	$ 114.11	$ 98.72	$ 110.17
	Total earnings for summer, including traveling and other similar expenses	$3,904.13	$2,412.40	$2,843.20	$9,159.73
	Average earnings for summer per man, including traveling and other similar expenses	$ 130.14	$ 120.62	$ 109.35	$ 120.52
	Average earnings per month per man, not including traveling and other similar expenses	$ 58.49	$ 53.07	$ 43.13	$ 51.36
	Average earnings per month per man, including traveling and other similar expenses	$ 64.80	$ 56.11	$ 47.78	$ 56.20

Note.—This table does not include the graduating class of 1912.

or less extent during the summer of 1912. The average number of months employed by the men who worked was 2.1, while the average earnings for the summer per man, counting only those who worked, was $120.52. The average earnings per month per man for those who were engaged were $56.20. Of interest are the last figures in the table giving monthly earnings for the sophomore, junior, and senior classes, respectively, showing that while the average earnings of the sophomores were $47.78 as compared with $56.11 for the juniors, the seniors in turn exceeded the other two classes with an average of $64.80 per month. Whether the increased earning power of the senior is due to his college training, to his increase in age with its natural consequent increase in ability, or whether it is due to the experience gained in the preceding summer vacations is impossible to state. No doubt all of these things have some influence on the increased earning power.

A total of $9,159.73 earned by 76 students working 163⅓ months is very satisfactory and speaks well for the earnestness and ability of the young men whose efforts have been so productive. Of the 163⅓ months employed, only 31¾ months can be classed as of a non-engineering nature, leaving 131$\frac{7}{12}$ months of engineering work. This shows that 81 per cent. of the total time employed was spent in work of an engineering nature. In studying the accompanying table it should be borne in mind that the graduating class of June, 1912, is not included therein. It also should be remembered that the seniors would probably have worked a greater number of months had they not been required to spend four weeks of their vacation in the summer school of surveying.

These earnings are of interest not only in themselves, as showing what the students are capable of doing, but they have an important bearing as indicating the character of the instruction which the students are getting during their summer vacations while employed in various industrial organizations. To a young man who spends nine months of each year in study in college, three months contact with an active, efficient business organization is of utmost value not only from an instructional

standpoint but from the disciplinary as well. Where such a large per cent. of the student body has had this active touch with engineering forces, the esprit de corps can be only of the best. And it is a very fair question to ask whether a system in which the great majority of students are actively employed in useful pursuits under competent engineers and business men during one sixth of each year is not equally as good as, if not better, than a system in which the student is for the greater part of the year under his university instructors. Not that the latter may not be as good as the former, but that the instructor and practitioner working together would seem to be better than either one alone can possibly be.

An improvement is possible in the utilization of the students' summer vacations in that a more effective and more systematic method should be used by the universities to secure the right kind of employment for all of its students who are physically capable of doing summer work.

FOUR VERSUS FIVE OR MORE YEARS OF COLLEGIATE EDUCATION.*

BY ALEXANDER C. HUMPHREYS,

President, Stevens Institute of Technology.

Under the above title I have been asked to prepare a paper for this meeting. I shall confine myself to collegiate education in preparation for the profession of engineering.

Among educators there is a strong and growing opinion, I fear, in favor of extending the four-year course which, for some years, has been the standard in the United States. The lengthening of the course naturally is suggested as the remedy for the crowding of the curriculum which has as naturally resulted from the rapid advances in engineering science made in late years. This remedy is the one on the surface, but it by no means follows that it is the best remedy.

The differentiating of the engineering profession into so many specialties, which has been more and more in evidence in late years, has also been used as an argument in favor of the proposed change. This may be used quite as cogently as an argument against the proposition.

Here in the United States, while the more general proposition is to extend the undergraduate course to five years, there are not a few who favor extending it to six and even seven years. As the claims are presented for more advanced study in some branches, and for the inclusion in the curriculum of new subjects, it is to be expected that those in authority will take the path of least resistance, and so propose that the students shall submit to a further reduction of the portion of their lives remaining to be devoted to productive effort.

* Paper to be read at the Minneapolis Meeting of the Society, June 24–26, 1913.

Particularly is this suggested remedy to be expected from the heads of the departments directly concerned.

The same tendency is to be seen in our every day life. As our needs, or our luxuries which we often mistake for needs, increase, the remedy at once suggested is the securing of an increase of income. In this case we might well consider two questions:

Will our lives be more complete if the new wants are satisfied? Cannot the income already in hand be spent to better advantage? May we not apply these tests to the question before us?

Will our students be more completely equipped for their life's work by giving them additional collegiate education? Not necessarily. Because there is a need, and a growing need in our profession for more instruction and training than can be covered in a four-year college course, it by no means follows that the colleges must charge themselves with the entire responsibility thus indicated. Have the colleges of engineering at any time in their history given their students a complete training for life's work and responsibility? The question needs only to be asked to be answered in the negative.

The college training in engineering is of great value to the one who takes advantage of his opportunities. The college affords the opportunity for acquiring a sound *fundamental* training within the shortest time and with the least expenditure of mental and physical energy. But this college training is not a necessity in the case of the men, perhaps exceptional, who have the brains, physical strength, and determination to persist in the face of difficulties.

Let us not forget that in every walk of life there have been and are now to be found men in the front rank who never had any college training and some who had little school training. It is true these were or are extraordinary men and must not be taken as patterns in planning for those of average capacity. But at least we can learn from the careers of these men that education can be obtained outside of academic surroundings.

Then should not the man of good ability and character be able to study effectively by himself after four years in college, following the years spent in the primary, grammar and high schools? Certainly he should be, provided he has been taught how to study and reason rather than crammed with facts and information.

Is it not a fact that if he was to become a master in any branch of the engineering profession, the student, in the past, found it necessary to make himself proficient and efficient after he had graduated from college? If this was true in the past, are the present conditions so different that in the four years of undergraduate work the student cannot acquire a sufficient grasp on science and mathematics as will enable him to reach the highest attainable rank *for which his personality qualifies him?*

No doubt some of those who graduate after four years will not, and perhaps could not, build a sufficiently high and strong structure on their college foundation to enable them to reach the loftiest heights of professional eminence; but this proves nothing. This measure of success involves more than formal education; it involves the questions of natural ability and character. Furthermore, there is not room for all at the top.

Are not we of the engineering colleges too apt to be led astray by thinking that we must turn out a finished product? Is it not true that too many educators believe, or at least act as if they believe, that all education is to be secured only within the school, college and university? A great many believe, or act as if they believe, that all culture must be so secured.

When the question is put to us squarely, we must all admit that this is not true, even as to culture. Certainly then it cannot be true as to technical education. Let us be frank and go farther and acknowledge that there is much which the engineer needs, if he is to gain eminence in his profession, which cannot be acquired in college, though he were to remain there to the end of his days. The college may develop scientists

but it remains for the school of experience to complete the training of the engineer, as far as it can be completed.

This question of the extension of the undergraduate years of study cannot be intelligently considered until we give adequate credit to the opportunities afforded by the combination of practice and study in the school of experience. If we are persuaded that some time should be added to the undergraduate course, how much time shall we add? Will one more year meet the demand created by the advances made and being made in engineering science? If not, will two years, three years, four years, five years, enable us to give our students a complete knowledge of all that is comprised within the limits of any one major branch of the engineering profession? We have only to consider the limitations to the knowledge of those who have devoted a life time to study in one branch of science to force us to negative this question.

Is it not true that if a man spent a life time within the college walls, when he found himself dying of old age there would remain much for him to learn? As a general proposition, is it not also true that as his time as a college student was lengthened, he would become less and less capable of applying his knowledge of science and mathematics practically and commercially? And here let us not forget, if we exclude the military branch of our profession, he is not an engineer who is incapable of meeting the conditions of fair commercial competition. I am prepared to go much farther and say that as there are two sides to every question, there are two sides to the question of college training even when limited to the four years. While unquestionably, in the case of those naturally qualified for advanced study, the balance is in favor of the college training, there is a minor disadvantage to be reckoned with, and this increases with the years spent in college. This disadvantage is the too great reliance which the *student* places on his college training and his failure to recognize and keep constantly in mind that his college work is only preparatory at the best. Furthermore, with weaker natures, the longer a man remains a student, only the less is he qualified to battle with, and the more he shrinks from, the stern realities of life.

Now let us briefly consider the second test question. Can the time now spent in school and college up to graduation from the four years college course, be spent therein more economically and efficiently? In considering this question we include the preparatory work in the graded schools.

The first thought that here comes to my mind is that the men who graduate from the Stevens Institute of Technology, average in age about 22½ years. It would seem as if a man should be a producer as well as a student at that age—a student he must remain in any case.

If we are to criticize the work of the schools in preparing our material for us, we must be sure that we are using our four years to the best advantage. Are we doing so? I believe that in some of our engineering schools we cannot do much more than we are doing. Certainly we cannot do better by crowding more into the curriculum. In some cases better work can be done by attempting less; by giving the students greater opportunity for assimilating that which is offered.

Perhaps the best opportunity for a more effective use of our four years is in the coördination of the several branches of study. Those in authority must be alive constantly to the necessity of watching for and providing against the over development of any one subject and the unnecessary overlapping of two or more subjects. A course in engineering, or any professional course can be kept in balance only by constant effort on the part of those in authority, and the loyal coöperation of the whole teaching staff. The conscientious, ambitious professor especially is inclined to increase his demands on the students and so rob the other professors of their share of the time and energy of the students. This is particularly so with a professor of engineering who is fully alive to the progress being made in his specialty. Here it is to be remembered that, with a class already working to a reasonable upper limit, if some new illustration of principle is to be introduced, it must replace some other illustration to be abandoned. Frequently this can be done without any loss educationally.

One thing is certain—just so soon as we give our students more to do than they can do thoroughly and with some degree of comfort and satisfaction to themselves for work well performed, we are not working them efficiently.

The question will here be raised—What grade of capacity and ability shall we take as a standard? Shall we adopt our requirements to the brilliant student, the student of good average capacity or the student who learns slowly?

We can at once eliminate those who are lazy, indifferent, or who pay *too much* attention to athletics or other student activities or any other interests than those connected directly with the course of study. I say too much attention to these other matters because I believe the students should be encouraged to give some of their time, thought and energy to student activities. We can sympathize with the earnest student who learns slowly, but it is not fair to hold back the majority for his benefit. He must take an extra year if necessary to complete the work of the four years. Of those who are naturally qualified for the engineering profession and are really in earnest and ready to devote themselves conscientiously to their studies, there should be comparatively few to take this extra year. If there are, it is a warning that the work of the several departments should be investigated. Certainly we cannot fairly adjust our courses to the exceptionally brilliant men. Nor need these men feel that they are losing time by having to mark time to enable the average men to keep in line. There is plenty for the brilliant men to learn and do if they have spare time and are willing to employ it sanely. On the average, I think those who come midway between the extremes named must furnish us with our gauge. And it is not unlikely that a large percentage of the really successful engineers will come from this section. They often make up in common sense what, by comparison, they lack in so-called scholarship.

While I do not look for any great improvement in the case of some of our colleges through a more efficient employment of our four years, I do believe that some educators who are warm advocates of extending the four-year course would do well to

examine themselves and their teaching carefully and frankly to determine if they are doing their best for their students in the time allotted; and especially *if they are loyally coöperating with their associates* in *securing* and *maintaining* the highest attainable coördination of the course as a whole. I am inclined to believe that a completely competent investigation of our colleges along these lines might be highly instructive and point the way to increased efficiency.

Now let us for a moment turn to the question of the quality of preparation as furnished by the graded schools. Is there one among us who believes that it is what it should be, or even what it might well be if we would throw away our prejudices, stop boasting, and really coöperate to improve conditions? At least let us not attempt to avoid responsibility by sticking our heads in the sand.

The first step should be to eliminate politics. A hard step to take in a country such as ours. If we cannot eliminate this dangerous influence, let us be frank and brave enough to acknowledge its presence wherever and whenever found.

The greatest fault, in my opinion, is that we hold the college out as the goal for all. We even deplore the fact that so few of those who enter the public schools, and especially the high schools, go on to the college. No doubt it is a cause for regret that certain ones do not go forward, but it is by no means a cause for regret in the case of the great majority. Many a good clerk has been spoiled by trying to make him into a teacher, lawyer, doctor or minister. Many a good mechanic has been spoiled by trying to make him into an engineer. And I am speaking from experience outside the college as well as inside. Our object should be to educate the masses for self-support and so for self-respect. This would work no hardship to those going forward to the college; whereas the present system does work a hardship for the great majority.

Another fault is that we do not regard with sufficient respect the duties of the teachers in the primary grades. They should not be considered as teachers of lower rank. If they do their work efficiently, the problems to follow are greatly

simplified. It is natural that the teacher should try for the step which is regarded as promotion. It is unfortunate that so much of the poorer teaching material is saddled on the primary grades.

A decided advance towards the solution of the problem we are now considering would be made if there could be a material increase in the salaries of our public school teachers, especially in the primary grades. And then there should be a commensurate increase in the required qualifications, and particularly in the *ability to teach*. There are many teachers and professors who possess but little of this ability. They may know, but they cannot make others know. Many of these misfits are temperamentally disqualified from doing the work of the classroom.

First of all, then, the pupils of our schools should be thoroughly taught and drilled in the "three Rs" and other fundamental studies. And here I am not speaking of preparation for any particular line of study to follow, but for the future in any line of effort in study or for self-support. I am afraid that we of the engineering colleges allow ourselves to forget that the lack of complete *facility* in reading, writing, adding, subtracting, multiplying and dividing, is a constant handicap to the student, pressed as he is for time. It is like giving a mechanic a poor set of tools and requiring him to perform his task accurately and *on time*. I am old-fashioned enough to believe that in our efforts to make the school studies less wearisome, we are weakening the students as to their powers of concentration and perseverance. This and the crowding of the curriculum has unquestionably led to superficiality.

There is also room for improvement in the matter of discipline. Our children should be taught to do right because it is right; failing to respond to this treatment, they should be taught that they must do as they are told to do. As far as possible they must be taught to govern themselves. Failing in this they must be governed. This would help in no small degree in better preparing for life's work, including collegiate study.

Here, as in every well-considered scheme, educational or otherwise, extremes are to be avoided and balance is to be sought constantly. Let the children from the first be taught to find pleasure in work well and thoroughly performed, not in work easily done. Time and energy might be saved by reducing the demands for memorizing facts. Let this line of instruction be kept to a minimum and the children early taught how to find their facts and reason correctly therefrom. I know it is argued by many experts that the memory must be cultivated. Again it is a question of balance. The brain can be so overtaxed as to be distinctly injured as a memorizing machine. Some are endowed with wonderful memories, and this is a most convenient tool for rapid and easy execution. But I have often found that unusual memorizing ability is not coupled with capacity for sound reasoning. Here and in other places I shall be misunderstood. I can only repeat, I am arguing against extremes, knowing positively that in too many cases extremes are in control.

After all, the proof of the pudding is in the eating. The average age of those entering Stevens is about 18½ years. Many high school graduates fail to pass the entrance examinations, and fail in the fundamentals. When we compare with the age at which the A.B. degree used to be taken, it is evident we have extended the years of preparation. Is the improvement in preparation commensurate with the years added? My answer is an emphatic "No."

Certainly, when we consider that we do not graduate our men until, on the average, they are over 22 years of age, we should very seriously consider every step of their educational progress, from the primary school forward, before we further reduce the working life of our young men. Especially should this point be conscientiously considered when we reflect that adding to the years in school and college *tends* in some directions to make the student less effective as a practitioner. Again a question of balance.

In conection with our investigations looking to greater economy in time, we may well keep our minds open on the

question of coöperative education as practiced for many years in the University of Glasgow and, as now well under way in a somewhat different form, in the University of Cincinnati. There are arguments for and against this scheme. The question is—which have the greater weight? Certainly the plan has the great advantage of combining practice with theory—the advantage which the graduate has, if he will avail himself of it, in studying while he practices. The results obtained by the Glasgow University speak well for their system.

The economic questions which are pressing for solution to-day and which threaten the peace and prosperity of the country, place a great responsibility upon the engineer, for he should be capable of giving material aid in the solution of these questions, so many of which have to do with the industries and public utilities. But we find the engineers of the country frequently wide apart on fundamental questions which are referred to them, and generally because these men have not been sufficiently trained on the investment feature of engineering. Engineering practice cannot be divorced safely from sound business practice. The weakness is evidenced in the attitude of bankers towards engineers' estimates on construction and earnings therefrom. While conditions have improved of late years, because the men who contral the money are more careful in selecting their technical advisers, we still hear the criticism, "Is that an engineer's estimate? Then add at least 50 per cent."

This may be considered an argument for extending the course. But better less theory, as long as it is accurate as far as it goes, and greater capacity for commercially practical application. At least let our students be taught that before or after graduation they must learn what the capable clerk has been learning outside the college during the college four years; and especially that he must learn the *principles* of accountancy, including such matters as depreciation; analysis of records; specifications and contracts; elements of banking, and the like.

Apart from the demand for more time for the engineering

course, there is coming to be a demand for a longer undergraduate course so that more time may be given to the so-called cultural studies. Are not too many of the professional educators particularly inclined to act on the belief, even if they do not hold to the belief under cross-examination, that the cultural studies are to be distinguished by labels, and that this intangible something we call culture cannot be acquired outside of the college or university? I do not propose here to be misunderstood as I have been at times. I believe the engineer requires all the culture, breadth of judgment and sympathy with his fellows that he can acquire or cultivate. Certainly he needs these as much as the member of any other profession; but the culture may not always take the same form. I have met people who were cultured in the ordinary acceptance of the term, who were out of touch and out of sympathy with the world in which and by which they were living; who had a store of knowledge, but with little ability to use it for their own good or the good of others; and who were unable to form a sound judgment based upon the stuff stored in their brains.

The strictly engineering studies can be so presented and taught as to have a truly cultural value. Do not let us extend our courses only for increase in opportunity for culture, unless we are sure of our ground.

In estimating the educational equipment of our graduates, let us compare, not with what we think we know and can do after ten, twenty or thirty years' experience since graduation, but with what we were actually on the day of graduation. Here is a mistake frequently made by the practicing engineer as well as by the educator.

It is quite in order that I should say a few words about post-graduate study. I have been misunderstood as condemning post-graduate study, and particularly at a dinner last winter given by the alumni of one of our colleges of engineering. For those temperamentally and otherwise qualified for the work, I believe thoroughly in college post-graduate work in engineering. Those men are the exception. Many who take up

this work would do better if they went out into the world to try to earn a living by putting into practice what they have learned in college. I am most firmly of the opinion that after four years in college the great majority of graduates would do better by securing their post-graduate training while practicing their profession. Even research work of the highest order is being done by men so engaged. The colleges are constantly profiting by the results thus obtained, carried back to the college for the benefit, not only of the undergraduates, but of the post-graduate students and even the professors.

But again there is the confusion of terms so common in the United States. What is post-graduate work *in engineering?* We hear that certain institutions are carrying on post-graduate work in engineering, when, upon investigation, we find the engineering studies are only those included in the regular four-year course. The post-graduate feature consists in the requirement that the students shall have first taken their A.B. or the equivalent. This is, in a sense, post-graduate study, but it is certainly not post-graduate study in engineering. The institutions which claim thus to do post-graduate work in engineering are, consciously or unconsciously, deceiving the public. All of our engineering colleges of first rank receive students who have taken their A.B., but I have never heard it claimed that these men are doing post-graduate work in engineering. One advantage these men have over those who are taking the so-called post-graduate studies first referred to is that instead of being in a class by themselves they have to keep pace with men who are required to work diligently if they are to graduate, and so they in turn are forced to apply themselves in a way which they probably had not been required to do in their previous college work. They have a better chance of acquiring habits of industry.

In conclusion, let me suggest, it is because so many college men allow themselves to be found advocating views which at least appear to favor the claim that the college and university hold a monopoly of all educational forces and agencies, that the opportunity is furnished for the attacks on the

colleges and institutes of technology, such as those voiced by the late R. T. Crane, of Chicago. The extreme statements on the part of the college man bring out still more extreme statements on the part of the self-made man. Again it is a question of balance between two extremes. Let us think seriously of this before we decide to hold our students longer away from the educational advantages offered by the school of practice and experience.

FOUR VERSUS FIVE OR MORE YEARS OF ENGINEERING EDUCATION.*

BY G. F. SWAIN,

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I must confess that I am somewhat of a pessimist on the subject of modern education and its results. The longer I live the more I am convinced that an education in the university of hard knocks is the best kind of a training, and that the colleges and technical schools are under a great temptation, to which they generally yield, to relax the discipline without which a young man will not gain the habits necessary for success. There is a great tendency to teach facts rather than reasoning, and there is too great a tolerance of poor work.

In these respects, the engineering schools are far less open to criticism than the colleges, because they deal more with concrete things, and because the student learns *by doing*, to a greater extent than in the study of the so-called humanities, which are taught mainly by lectures. Moreover, in the study of engineering, the student is studying subjects in which the truth of his results and the accuracy of his reasoning are subject to test, which is not the case in many of the subjects making up the usual college course, except in natural science.

For these reasons, I believe that a four-year course is long enough for the large majority of engineering students. I have no question, however, of the truth of two other statements, namely:

1. The four-year course in engineering should not be a highly specialized course, but should touch mainly the fundamental principles. It should also broaden the student's point

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of view by giving him some knowledge of related sciences, of literature, history and economics, so that he may be informed regarding the problems which confront him as a citizen and as a social being. He may thus be stimulated to continually broaden himself in these directions throughout his life, thereby adding to his power and influence as a man among men, and to his possibilities of enjoyment. Our four-year technical courses are too narrow and aim to carry men too far in special lines.

I have often stated and reiterated these beliefs and will not here develop them farther.

2. The exceptional man, that is to say, the man who can profit by collegiate study, should have the opportunity, and should be encouraged, to take a longer period than four years for his engineering education, not only in order to pursue his technical subjects to a higher point, but to broaden himself still farther in the humanities. Five- or six-year courses should, therefore, be provided *in a few schools but not in all;* but care should be taken that no one who is not qualified by temperament and preparation to fully profit by such longer courses should be encouraged or allowed to take them. During this course, the vacations should be devoted to practical work in the shop or the field.